Space Weather Technical Forecast

Issued on Saturday, 18 May 2024 at 13:30 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-class flares likely with a slight chance of isolated X-class flares throughout. G1-G2 (Minor/Moderate) Storm conditions likely day 3 and 4 (20 and 21 May) with a chance of peak G3/Strong Storm intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was at Moderate levels with a peak M7.2 flare at 17/2108 UTC from AR3685, with the next highest a C7.2 flare observed at 18/0538 UTC from AR3679. There are currently ten sunspots on the visible disc. AR3680 and AR3681 decayed during the period and AR3671 rotated over the northwest horizon. A new, as yet unnumbered, small unipolar region developed in the northeast disc. The largest region on the disc is AR3685 (Ehi/Beta-Gamma) in the southeast. The region is composed of a number of large, mature spots with several smaller spots of mixed polarity present, though these appear to evolve slowly. AR3679 (Esi/Beta-Gamma) near centre-disc in the southern hemisphere is the next largest region and has been the source of some C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 (Dsi/Beta-Gamma) in the southwest indicates modest magnetic complexity with numerous small spots at this time. The other sunspot regions are generally smaller, simpler and more stable.

The M7.2 flare at 17/2108 UTC from AR3685 produced Type II and IV radio emissions with a CME subsequently visible across all imagery. Analysis has been conducted on this CME and modelling suggests an arrival at Earth, most likely late day 3 (20 May) or perhaps very early day 4 (21 May).

Solar Wind / Geomagnetic Activity: A CME arrival was observed by ACE at L1 at 17/1240 UTC, with initially background to slightly elevated winds (around 380-420km/s) increasing to persistently slightly elevated levels around 460-490km/s following CME arrival. Density of the solar wind was average at first, but erratically fell to below average levels following CME arrival. Later in the period, more generally average density has was observed. The Interplanetary Magnetic Field (IMF), Bt, was at moderate levels initially, and rose sharply following the CME arrival to a peak of around 17nT (strong) before steadily reducing to around 6nT (weak) by 18/1200 UTC. The north-south component Bz was predominantly moderately negative following the CME arrival, steadily easing to become weakly negative by the end of the period. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity varied between Quiet to G2/Moderate Storm levels.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels on a slow decline, but above normal background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to moderate levels. The associated 24-hour fluence has remained below the Active threshold. Observed fluence at 18/0000 UTC of 2.87e6 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Continued Low to Moderate activity is expected with isolated M-class flares considered likely and a slight chance of isolated X-class (High) activity. AR3685 in the southeast is most likely to be the source of significant flare activity.

Solar Wind / Geomagnetic Activity: There is an unlikely, but slight chance of a glancing impact from a CME late on day 1 (18 May) or early day 2 (19 May). A more notable CME arrival is expected at Earth late day 3 (20 May) or perhaps very early day 4 (21 May), resulting from the M7.2 flare of AR3685 that occurred late on 17 May.

In the absence of any CME arrivals solar winds are forecast to ease from slightly elevated levels to background speeds early in the period, with no significant coronal hole enhancements expected.

Quiet to Unsettled conditions are expected through the early period, with only a slight chance of Active to G1/Minor Storm conditions on days 1 and 2 (18 and 19 May) subject to the unlikely potential for a CME arrival. Confidence is greater for a more significant CME enhancement late day 3 (20 May) into day 4 (21 May) with G1-G2/Minor-Moderate (Kp5-6) activity likely and a chance of reaching G3/Strong (Kp7) levels of activity at peak. Activity should then subside towards Quiet to Unsettled levels again by the end of day 4 (21 May).

Energetic Particles / Solar Radiation: Proton flux is below the S1/Minor Storm threshold, on a declining trend, but above normal background levels following recent flare activity. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. High energy electron flux is at background to moderate levels, however there is the potential for electron flux to rise and potentially reach persistently high levels on day 2 and 3 (19 and 20 May). Any rise in electron flux is expected to be curtailed by further CME influence, most likely occurring late day 3 (20 May) or early day 4 (21 May).

The associated 24 hour fluence is expected to continue a rising trend between days 1 and 3 (18 and 20 May) with a chance to reach the Active threshold on day 3 and perhaps also early day 4 (21 May), though dependent on the exact arrival time of the forecast CME enhancement. MOSWOC REFM provides reasonable guidance although perhaps slightly under representing the risk of reaching the Active threshold later in the period.

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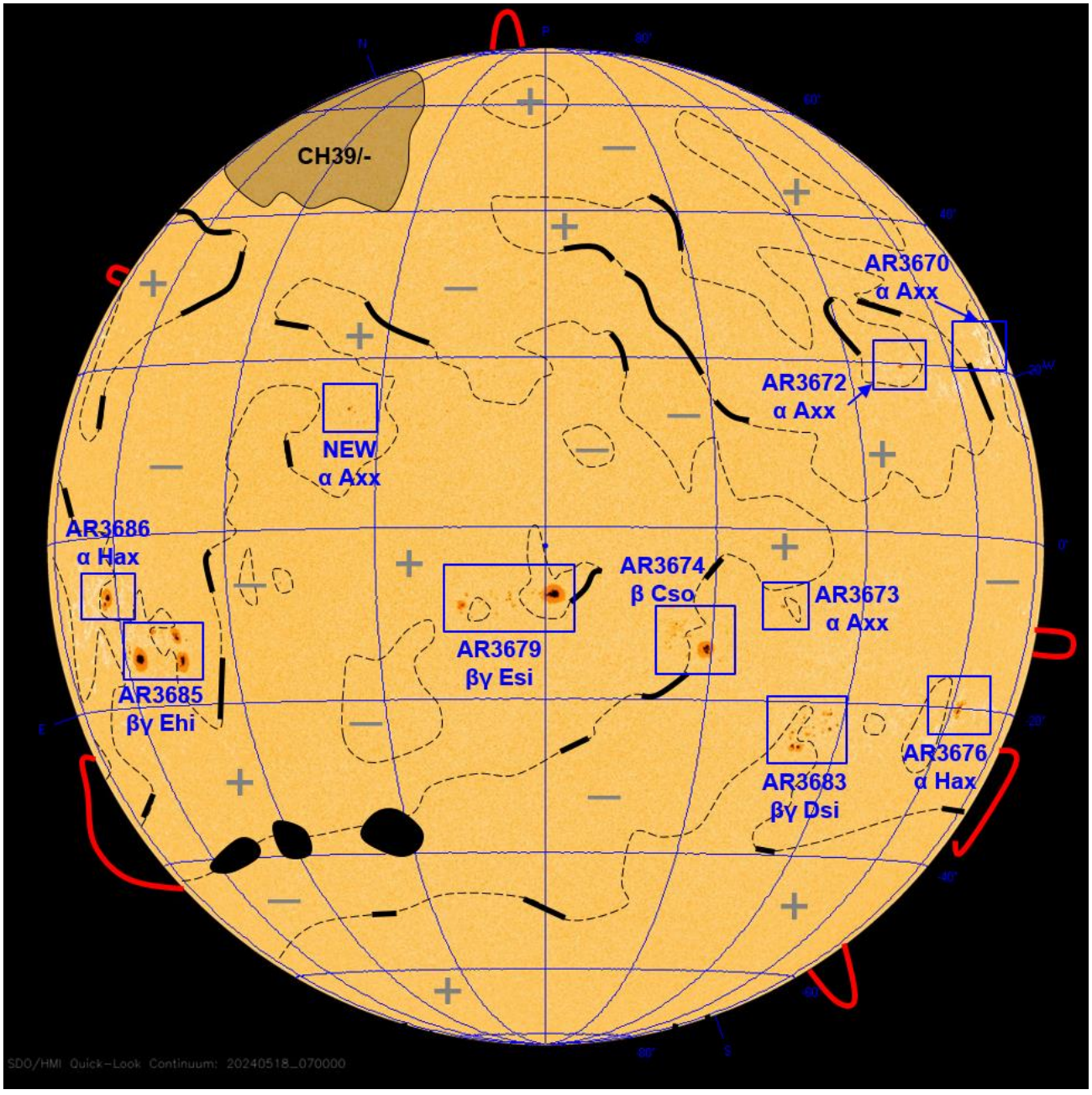
Figure 1. Solar Analysis Valid 18/0700 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two potentially Earth-directed CMEs currently feature in the forecast period. A filament eruption from the northeast disc around 15/1000 UTC resulted in a CME that has been modelled to pass north of Earth's orbit late day 1 (18 May) or early day 2 (19 May). Although considered highly unlikely, there is a slight chance of a glancing impact from this CME. Late on 17 May a complex 'double-structured' moderately-fast CME was seen in coronagraph imagery associated with the M7.2 flare of AR3685 in the southeast disc. Type II and IV Radio Emissions as well as a distinct EUV wave signature were observed. Modelling of this feature suggests that an Earth-directed CME has occurred, with an expected arrival late day 3 (20 May) or perhaps very early day 4 (21 May).

In the absence of any CME arrivals solar winds are forecast to ease from slightly elevated levels to background speeds early in the period, with no significant coronal hole enhancements expected.

Quiet to Unsettled conditions are expected through the early period, with only a slight chance of Active to G1/Minor Storm conditions on days 1 and 2 (18 and 19 May) subject to the unlikely potential for a CME arrival. Confidence is greater for a more significant CME enhancement late day 3 (20 May) into day 4 (21 May) with G1-G2/Minor-Moderate (Kp5-6) activity likely and a chance of reaching G3/Strong (Kp7) levels of activity at peak. Activity should then subside towards Quiet to Unsettled levels again by the end of day 4 (21 May).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	10	5	70	70
Strong	G3	No	1	1	20	20
Severe	G4	No	1	1	5	5
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
15/1632	Partial	Filament Eruption	NE	630 km/s	19/0000 UTC +/- 7 hours	Expected miss. Slight chance of glancing impact
18/0029	Partial	Flare	AR3685	1049 km/s	20/1800 UTC +/- 7 hours	Moderate confidence in analysis and impacts

Figure 2: Latest Enlil forecast with Ensemble

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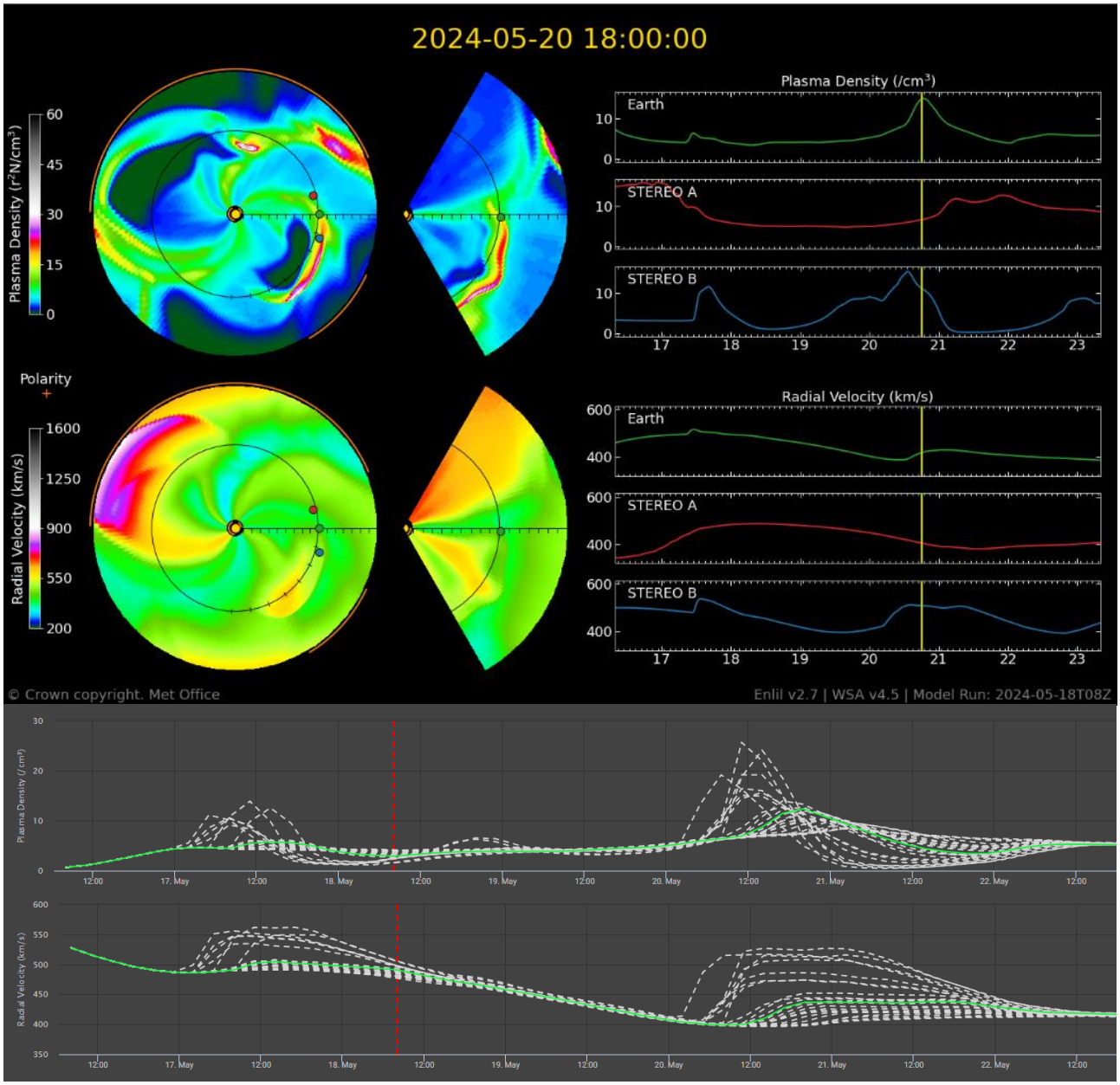

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Radio Blackouts - X-Ray Flares:

There are ten sunspot regions on the visible disc. AR3685 (Ehi-Beta-Gamma) in the southeast is considered to be the most likely source for X-class activity, having produced an X2.9 flare on 15 May and the most recent M7.2 flare, late 17 May. The region is composed of a number of large, mature spots with several smaller spots of mixed polarity present, though these appear to evolve slowly. AR3679 (Esi/Beta-Gamma) near centre-disc in the southern hemisphere is the next largest region and has been the source of some C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 (Dsi/Beta-Gamma) in the southwest indicates modest magnetic complexity with numerous small spots at this time. The other sunspot regions are generally smaller, simpler and more stable.

No significant returning regions are expected through the period or strongly signalled in far-side sounding data, with all the current notable flare producing regions remaining on the visible disc. As such, the current flare risks have been maintained through the period pending further developments.

Continued Low to Moderate activity is expected with isolated M-class flares considered likely and a slight chance of isolated X-class (High) activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

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Solar Radiation Storms - (High Energy Protons):

Proton flux is below the S1/Minor Storm threshold, on a declining trend, but above normal background levels following recent flare activity. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. AR3685, the largest and most actively flaring region on the disc will remain in a generally unfavourable position (in the eastern hemisphere) for significant proton enhancement through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 is at background to moderate levels, however there is the potential for electron flux to rise and potentially reach persistently high levels on day 2 and 3 (19 and 20 May), with lower orbits having been highly charged by numerous strong CME arrivals in the past week or so. Any rise in electron flux is expected to be curtailed by further CME influence, most likely occurring late day 3 (20 May) or early day 4 (21 May).

The associated 24 hour fluence is expected to continue a rising trend between days 1 and 3 (18 and 20 May) with a chance to reach the Active threshold on day 3 and perhaps also early day 4 (21 May), though dependent on the exact arrival time of the forecast CME enhancement. MOSWOC REFM provides reasonable guidance although perhaps slightly under representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	40	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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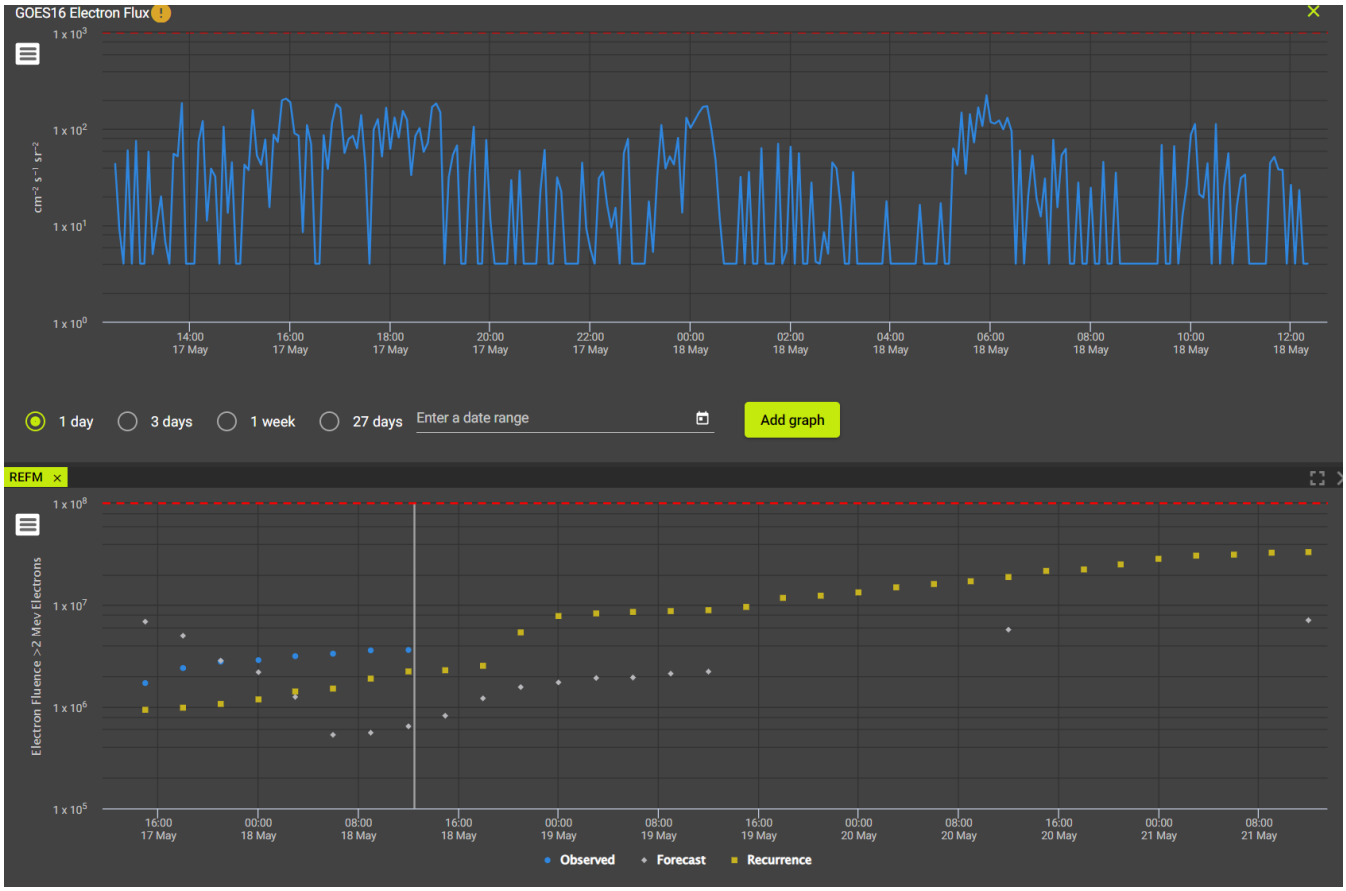
Figure 3: Latest GOES16 Electron flux and MOSWOC REFM forecast with recurrence



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